Defense Technical Information Center Compilation Part Notice

ADP023079

TITLE: Dazzle and Obscuration Strategies for Light Armoured Vehicles

DISTRIBUTION: Approved for public release, distribution unlimited

This paper is part of the following report:

TITLE: Proceedings of the Ground Target Modeling and Validation Conference [13th] Held in Houghton, MI on 5-8 August 2002

To order the complete compilation report, use: ADA459530

The component part is provided here to allow users access to individually authored sections of proceedings, annals, symposia, etc. However, the component should be considered within the context of the overall compilation report and not as a stand-alone technical report.

The following component part numbers comprise the compilation report:
ADP023075 thru ADP023108

Dazzle and obscuration strategies for light armoured vehicles

John Rapanotti* and Marc Palmarini†

*Defence Research and Development Canada – Valcartier, Val-Bélair (QC), G3J 1X5
†Onix Integration Inc., Ste-Foy (QC), G1V 4P1

ABSTRACT

Battlefield obscuration strategies, optimized for Main Battle Tanks in traditional high intensity conflicts, are inadequate when applied to Light Armoured Vehicles. LAVs are vulnerable to many threats and sufficiently different in design, capability and battlefield environment to benefit significantly from new strategies. Factors influencing this requirement include: i) the development of sensors with increasing accuracy and precision, ii) the need to minimize obscurant interference with vehicle sensors and other countermeasures, including active armour and explosive reactive armour, iii) the need to develop hemispherical obscurant coverage extending into the millimetre wave range, iv) grenades are needed to better match the increased tempo from greater vehicle speed, mobility and turret slew rate, v) the automatic configuration and selection of grenade burst patterns based on on-board processing and vehicle networks.

Spectral coverage in the visible to long-wave infrared regions is adequate, but trends in missile design are leading to the development of hybrid seekers including, laser designating, MMW seeking and imaging-infrared seeking capability accelerated by MEMS technology. With increased tempo, the time needed to achieve full obscuration becomes critical. Dazzling of a detected threat can be used to disrupt aiming and firing a second missile until full obscuration is achieved. Dazzling can also be used with the laser-illumination detection of optical systems. A generic threat response, based on dazzling and visible/IR/MMW grenades is preferred because of the large number of possible threats and the difficulty in developing practical identification strategies.

New dazzling and obscuration strategies, based on extensive knowledge acquired through field trials, will be analyzed and developed using ModSAF. These new strategies and the approach used to develop them will be discussed in the paper.

1. INTRODUCTION

Obscurants, dispersed by grenades, are an effective means of protecting the LAV against weapons using sensors for targeting and guidance.[1–5] Successful screening materials, such as metal flake and chaff, can reduce the effectiveness of anti-armour threats operating in the visible to MMW ranges. Brass flakes, typically 2-6μ in diameter, offers protection from visible to long-wave infrared, while chaff, consisting of aluminum coated fibres 10mm long and 25μ in diameter, is useful in extending coverage into the MMW range. Small particle dimensions are essential in developing a smoke screen that will remain suspended, or persisting, for the required 30s. Chaff dimensions, which can be relatively large to screen effectively nonetheless falls at an acceptable 0.3m/s or 9m in 30s.

Each grenade contains an explosive charge, which after a suitable time delay detonates to produce a cloud of uniform density. This cloud, approximated as an 8m sphere in this study, is actually an oblate spheroid aligned with the axis of the grenade and controlled by the launch angle and velocity of the grenade. Since the launcher is fixed to the turret, other variables affecting the launch include: vehicle pitch, roll and speed, turret position and turret slew rate. At low operating temperatures, the launch velocity is reduced resulting in a lower burst height. Once the initial momentum of the explosion has dissipated, atmospheric variables such as wind and turbulence distort and displace the sphere.

In peace-keeping roles, the grenade launcher will be an essential component launching a variety of grenades ranging from CS gas and illumination flares to fragmentation grenades. Unlike other platforms, land vehicles are relatively inexpensive and vulnerable to many threats.[6,7] These factors discourage the development of threat identification and favor a generic threat response like smoke screens. Since a grenade launcher will always be available, smoke screens will continue to play an important role in vehicle survivability.

Ground Target Modeling & Validation Thirteenth Annual Conference, August 2002

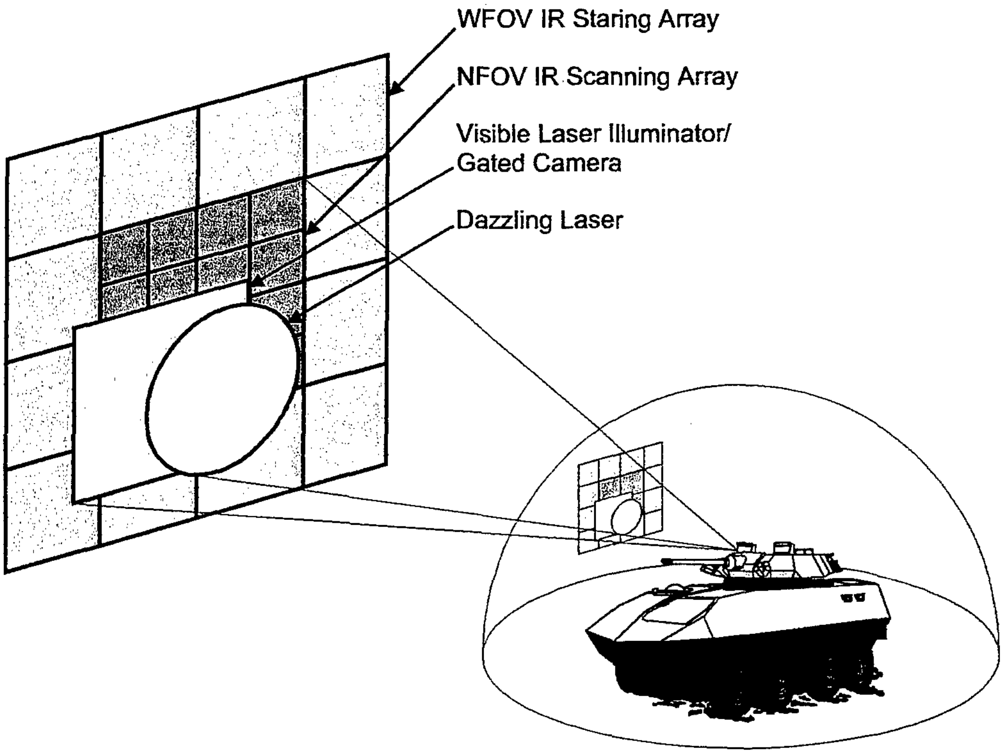


Figure 1. Vehicle staring and scanning optics. Most threats, such as missiles, are smaller than one pixel of the staring array. Detection can be improved by scanning with a higher resolution array. A visible laser illuminator and a gated camera can further improve detection especially during low-light conditions. The visible and infrared imagery can be combined to provide a composite display for the crew. Dazzling can be used, when appropriate, to disrpupt aiming and guidance while the main turret slew to position.

The interval between threat detection and full obscuration will be at least 1.5s. During this time, dazzling can be used to disrupt aiming or firing a second missile. The dazzling optics are a narrow field of view system housed in a mini-turret mounted on the main turret. Included in the mini-turret would be a laser illuminator and gated camera, ALBEDOS,[8] to actively detect various optical systems, by laser illumination, in the ALBEDOS field of view. The optics used for detection and dazzling are depicted in Figure 1.

The sections below will describe the factors influencing vehicle survivability and how dazzling and obscuration will be used to counter potential threats.

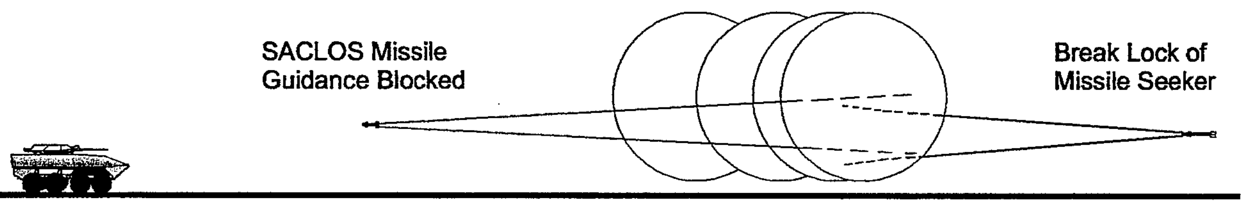
[illegible]

Obscuration screens are a practical means of defeating many threats by direct interference with targeting and guidance functions. Some factors influencing the use of obscurants with LAVs are discussed below.

[illegible] New generations of sensors are being developed providing greater levels of situation awareness. These performance improvements are being accelerated by MEMS technology to produce even smaller, hybrid systems with new properties based on combined characteristics. An example of a new detector is the laser detecting HARLID^{TM}. With an angular resolution of $\pm 1°$, it is a significant improvement over existing systems.[9] A current laser warning receiver with a typical resolution $22.5°$, can detect a threat but not provide the position with sufficient accuracy. The only reasonable response from the crew is to launch smoke grenades and back the vehicle away from the threat. Based on the HARLID^{TM}technology, a laser threat is detected in less than 1msec, but with a resolution $\pm 1°$ not accurately enough to position the main gun. Combined with an IR staring array, the stream of pixels corresponding to the laser source can be analyzed to determine the nature of the threat and fix the position. The information is then sent to the

Fire Control System and to other vehicles through a network.[10] With a staring array operating at 60Hz this process takes less than 20msec, considerably less than the typical 1.5sec it takes to set up sufficient obscuration.

Obscuration over a wide spectrum can be used to defeat various missile systems including optically sighted, Semi-Active Command to Line Of Sight, and laser or MMW semi-active homing missiles. SACLOS missiles use a beacon facing the launcher to correct any deviations between the missile and the launcher crosshairs. Earlier designs were easily defeated by placing false beacons on the vehicle. These false beacons were much more powerful than the missile beacon and were used by the launcher to provide false trajectory data to the missile. Improvements in missile design, by encoding the beacon signal, resulted in a missile that could not be easily jammed. Both designs are susceptible to smoke screens, as shown in Figure 2, and can still be defeated by obscuring the flight path to the vehicle. The launcher no longer sees the target vehicle and the beacon signal is scattered and absorbed by the obscurant. Obsuration will also stop designated missiles since the laser or MMW beam cannot penetrate the smoke screen. New missile designs based on hybrid seekers: laser semi-active homing and both imaging IR and MMW imagery are being developed which will require careful manoeuvring forcing the missile to reacquire the target and correct trajectory over the distance between the vehicle and smoke screen.



The LAV is protected by a screen formed by 4 grenades centered on a 36m radius. The smoke screen blocks the signal from the SACLOS missile guidance beacon. A missile seeker, initially locked on the vehicle, breaks lock and has only 32m to reacquire the target.

Obscurants designed to interfere with threat sensors will also interfere with vehicle sensors. A sufficient downrange distance is required to use active armour successfully. Careful selection and placement smoke screens is important in providing sufficient but not excessive downrange coverage. There is probably an optimum distance at which the smoke screen should be established, which can be determined through simulations with ModSAF.

Light Armoured Vehicles will be deployed to peacekeeping environments where attacks can come from any direction. Sensors are being developed to provide the necessary hemi-spherical coverage but current grenade launchers, designed for Main Battle Tanks, need to be redesigned to provide a similar coverage. Improving sensor technology is also increasing the spectral range of weapons from visible and infrared to millimetre wave operation.

Improved sensors and digital processing will automate many of the functions necessary in improving vehicle survivability. This automation with increased vehicle mobility and turret slew rate will shorten response timelines and increase operational tempo. The grenade launch velocity can be increased and the time delay shortened accordingly but the interval between threat detection and full obscuration will still exceed 1s. During this interval, dazzling is considered to be a reasonable countermeasure since most anti-armour threats rely on an operator to aim or guide the weapon.

Obscuration will be set up according to the nature and location of the threat detected. This could be carried out automatically by Defensive Aids Suite processors based on local sensors or information transmitted over a network. The grenade burst patterns would depend upon threat detection and vehicle operation, described in detail below.

The current MBT launcher has a 45° launch angle, which presents several problems. Any variation in the launch velocity, usually a function of the operating temperature, results in significant variations in the burst height. At very low temperatures, grenades often hit the ground before exploding. A second problem is the excessively long time delay, often in excess of 2.5s, required by the longer flight path. These problems can be avoided by

providing additional launch tubes at a shallower angle while retaining the 45 ° launch tubes for fragmentation grenades. Additionally, the shallower launch angle would be more appropriate for CS gas grenades.

[illegible]

A simplified governing equation including a given launcher angle, initial velocity and required launcher height can be expressed as:

$$h = h_o + V_o \sin(\alpha + \theta)t - 1/2gt^2 + V_s \sin(\alpha)t - V_o \sin(\alpha)t \qquad (1)$$

where θ, is the launch angle (either 20°, 45° or 70°),

α, is the vehicle incline,

h_o, is the height of the launcher, set to 2.5m,

h is the height of the grenade, 4.3m at 20°, 18.0m at 45° and 26.7m at 70°, on flat ground

t is the time of flight, 1.5s,

V_o, is the initial grenade velocity, 20 and 25m/s,

V_s, is the vehicle velocity and

g, is acceleration due to gravity.

The burst pattern for the MBT, shown in Figure 3, can be improved by decreasing the grenade launch angle, increasing the launch velocity and shortening the time delay. Based on trials, the velocity is increased to 25m/s and the time delay is fixed at 1.5s. Solving for the burst height, for various launch angles and vehicle incline angles, results in a family of curves shown in Figure 4. For a wide range of vehicle inclines, the 20° angle gives the most acceptable distribution of burst heights. To maintain the requirement for fragmentation grenades, the 45° angle is retained for mid-level coverage. Further protection against top-attack weapons is provided with a single grenade at 70 °. A comparison between the MBT grenade system and the new LAV configuration is presented in Table 1. The total number of grenades has increased from 8 to 48 seems excessive but from previous studies[10] an automated system can be made more reliable if all the components are accessible by the computer. This implies installing all the grenades in the launcher instead of stored in the vehicle. The new burst pattern configuration for the LAVs is shown in Figure 5.

[illegible]

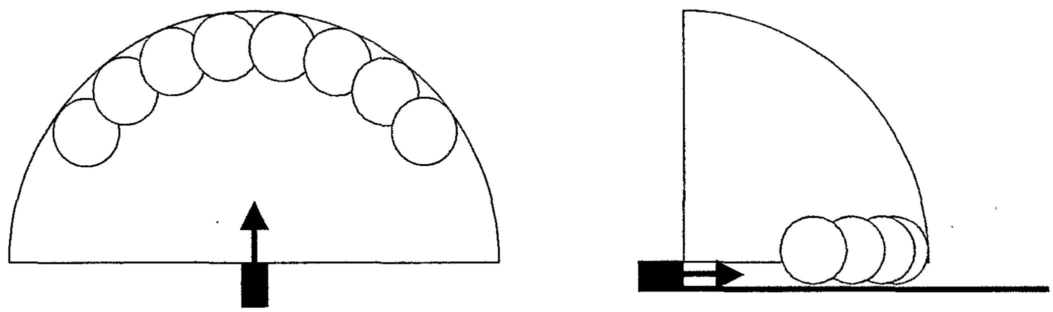
Based on the grenade configuration shown in Figure 5, various scenarios can be developed for further analysis. The objective is to automate the threat response as much as possible and reduce the crew work load.

[illegible] In the first scenario, a threat is detected while the vehicle is stopped or moving too slowly to avoid the threat. The recommended burst pattern is shown in Figure 6. The ground screen is formed with four grenades biased toward to rear so the driver can backup under cover. All three mid-level grenades including the 70 ° grenade and two aft mid-level grenades are used to counter a possible top attack. This allows the vehicle to back up and countermanoevre for at least 30s. In a reasonably quiescent atmosphere, the 45° and 70° grenades should provide coverage well beyond the 30s required.

[illegible] For a moving vehicle, which is less vulnerable to sensor-fuzed submunitions, the burst pattern in Figure 7 is suggested. Both ground and mid-level grenades are used to form a series of screens, biased in the direction of vehicle travel. This procedure can be automated by launching the next set of grenades when the angle between the vehicle and the last grenade in the series approaches the angle of the threat detected. While this ensures that the vehicle remains hidden, it may still be possible to locate the vehicle by extrapolating grenade trajectories back to the launcher. If the driver, intentionally slows down or stops the vehicle, the variation of the scenario described above would be used provide protection while backing up.

[illegible]

The detection of threats by the staring array, the time to slew the scanning optics towards the threat and the time to slew the main threat are some of the stochastic variables that influence the usefulness of dazzling as a countermeasure. As suggested by Figure 8, if the time to slew the dazzling laser into place is excessive then the advantage over launching grenades may be negligible. Dazzling can be used preemptively with the scanning optics shown in Figure 1. Automatic processing can be used to quickly detect any anomalies against the background.



Dispersion - plan view

Dispersion - elevation view

Typical grenade-burst pattern for a Main Battle Tank. Each grenade explodes close to the ground forming 8m diameter spheres. A total of eight grenades are launched at 45° forming a smoke screen about 45m wide, 30m from the vehicle. The LAVs are expected to operate in very different threat environments requiring new strategies.

A new grenade launcher system, based on the requirements of Light Armoured Vehicles, is described. This approach is suitable for further analysis with wargaming simulations. ModSAF will be used to determine the best grenade configuration by constructing virtual battlefields and simulating vignettes based on accepted tactics and doctrine. Vehicle simulators will be used to develop man-machine interfaces and analyze vehicle and crew performance.

The grenade configurations described meet the LAV requirements of:

i) improved sensors,

ii) minimized obscurant interference,

iii) hemispherical screening from visible to millimetre wave range,

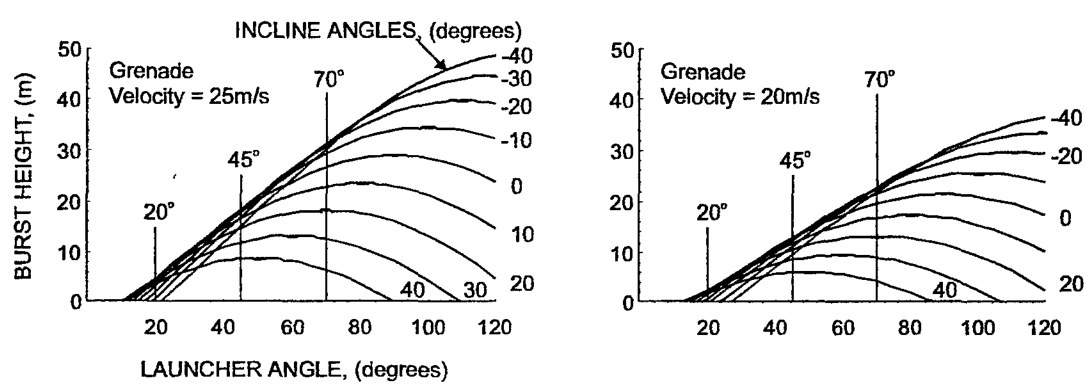
iv) increased operational tempo,

v) automatic configuration, selection and response.

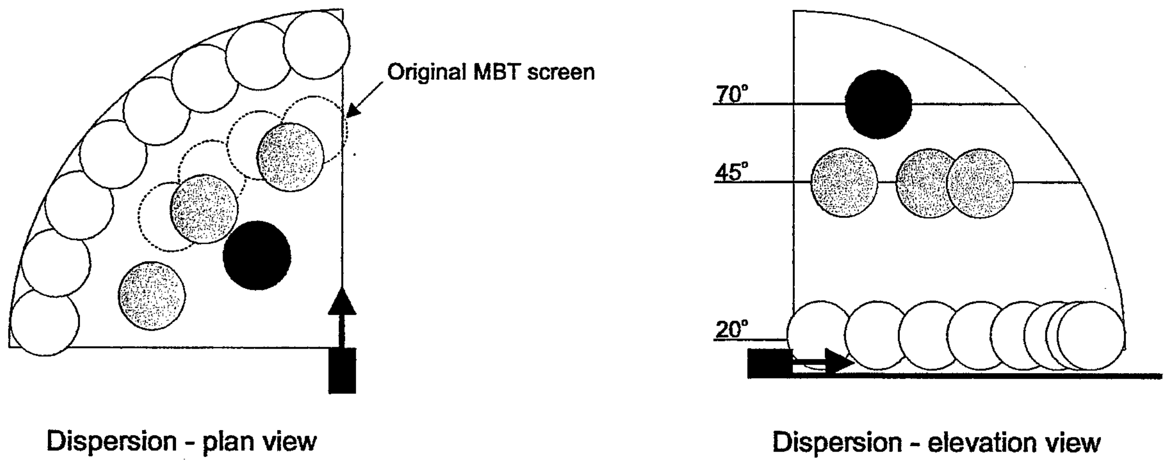
The original 45° launch tubes are retained for fragmentation grenades and new launch tubes at 20° are available for CS gas grenades.

[illegible] Main Battle Tank and Light Armoured Vehicle Grenade System Parameters

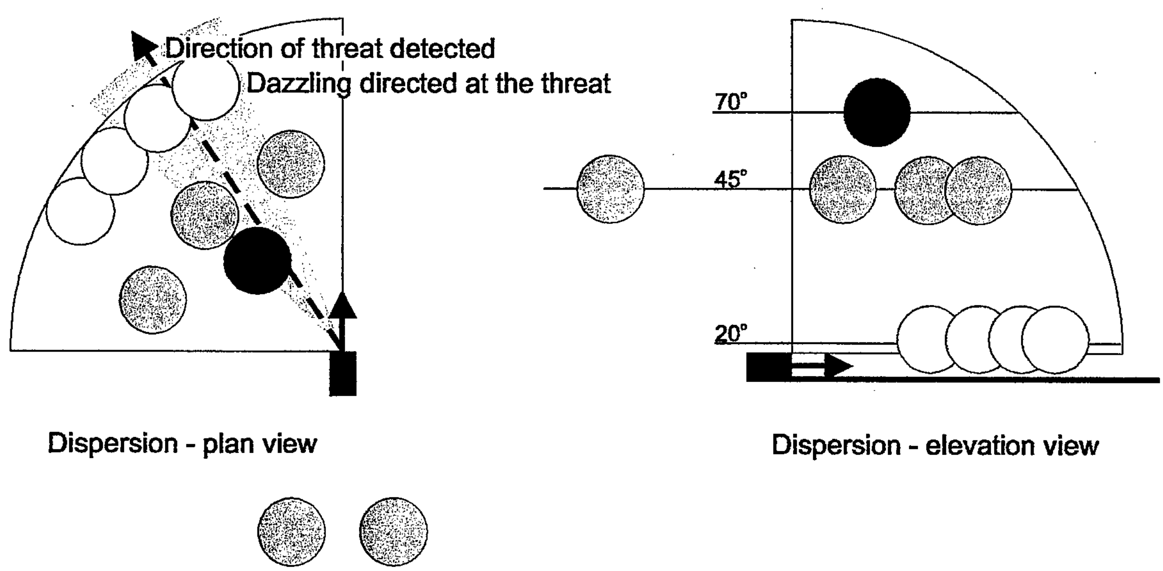
[illegible]	[illegible]	[illegible]
[illegible] [illegible]	Metal Flake Visible/IR	Metal Flake/Chaff Visible/IR/MMW
[illegible] [illegible] [illegible]	2.5s (approx.) 8m 30m	1.5s 8m 40m
[illegible] Ground level Mid level Top	[illegible] 8 launched at 45° — —	[illegible] 32 launched at 20° 12 at 45° 4 at 70°



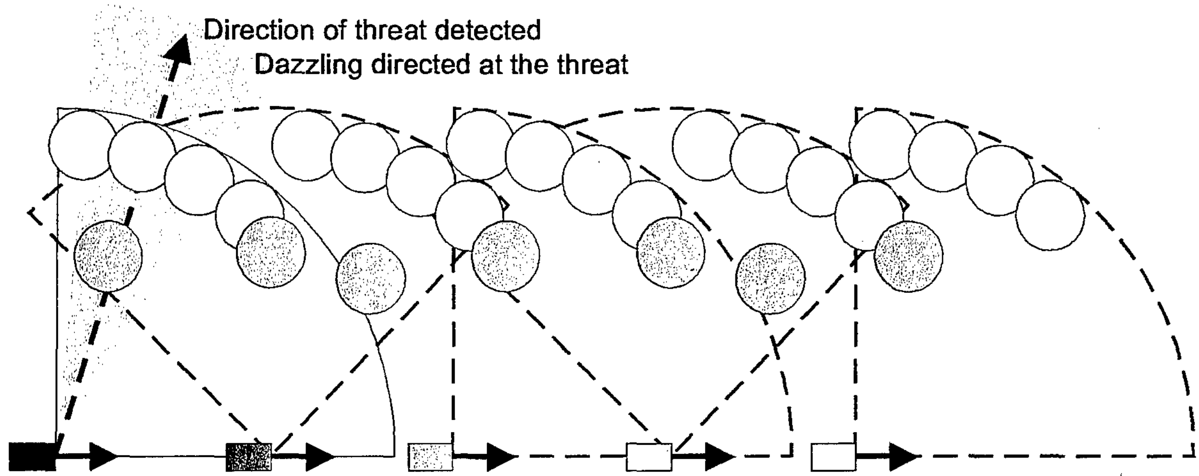
[illegible] Solution of the launcher equation for various launcher and vehicle angles. The effects of cold-environment operations are represented by launches at 20m/s. For incline angles from -40 ° to 40° most grenades explode before hitting the ground. The grenade at 70° would rarely be needed unless optimum coverage is required for a stationary vehicle. Other parameters include a delay time of 1.5s, a grenade initial velocity of 25m/s, a vehicle forward speed of 4m/s (14.4km/hr) and a launcher height of 2.5m.



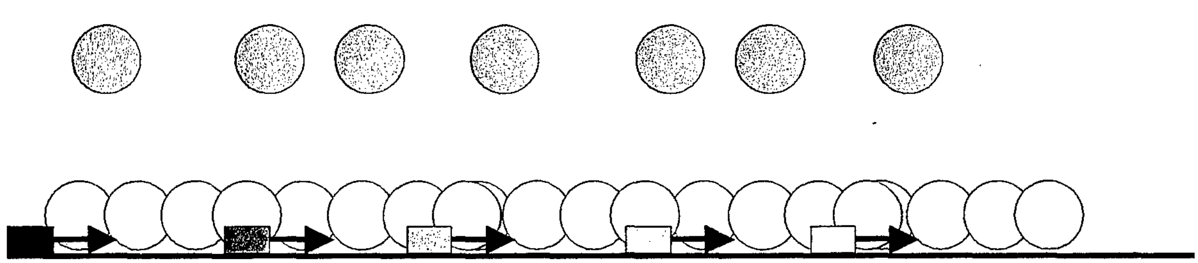
Typical grenade-burst pattern based on new LAV requirements, including a perimeter screen set at 40m, and for each quadrant three mid-level bursts at 45° and one at 70°. The original MBT screen for one quadrant is also shown.



For slowing, stopping and backing-up manoeuvres, a perimeter screen is set up with 4 grenades, a total of 5 mid-level grenades including 2 from aft launchers are used for additional coverage. For stationary vehicles, an additional grenade can be launched at 70 ° to counter sensor-fuzed submunitions.

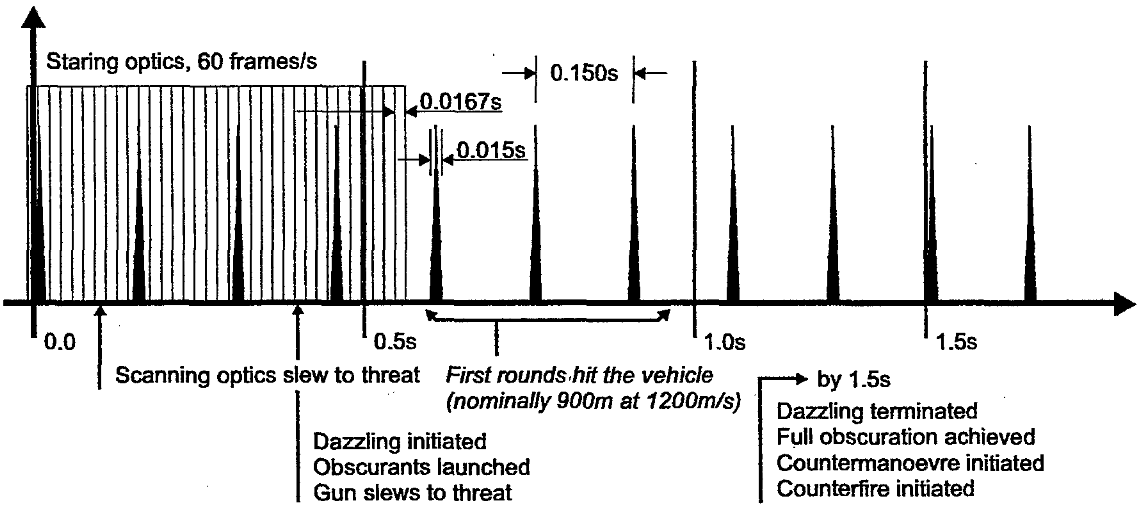


Plan view of typical dispersion patterns for a moving vehicle.



Elevation view

[illegible] Typical dazzling and grenade-burst patterns, automated for a moving vehicle. Five time intervals are shown. Dazzling is used to disrupt aiming or direct fire until the screen is in place.



[illegible] An automatic weapon firing 400rds/min is detected by a staring array. A scanning optical system slews towards the threat and a dazzling laser is activated to disrupt the gunner. At the same time, smoke grenades are launched and the main turret slews towards the threat. By 1.5s, full obscuration is in place and the main gun can be fired using data from the Fire Control System or a Vehicle Network if available. These events are all stochastic in nature and can be analyzed in detail using ModSAF.

The author would like to thank Mr. Paul Brière and Dr. Gilles Roy for their useful advise and discussions on the subject of smoke grenade design and IR obscurants.

1. D. Sanschagrin, G. Couture, G. Roy and P. Brière, "Développement d'une Grenade Fumigène de 76 mm pour Véhicules Blindés: Correction du Mouvement Ascendant de l' Ecran Fumigène", DRDC-Valcartier Technical Memorandum TM-9510, February 1995.
2. G. Roy, P. Brière, D. Sanschagrin and G. Couture, "Development of a 76-mm Visual and IR Smoke Screening (VIRSS) Grenade for the Wegmann Launcher", DRDC-Valcartier Report R-9605, December 1996.
3. D. Sanschagrin, "Parameters Affecting the Performance of Immediate Screening Smoke for Armoured Fighting Vehicle Protection", DRDC-Valcartier Technical Memorandum TM-9829, December 1999.
4. D. Sanschagrin, "Effect of the Bulk Density of a Brass Flake Obscurant on the Dissemination of an Explosive Smoke Device (U)" DRDC-Valcartier Technical Memorandum TM-9836, December 1999.
5. D. Sanschagrin, P. Brière and J. Dumas, "Preliminary Field Trial of the Advanced Development Model of the 76-mm VIRSS Grenade (U)", DRDC-Valcartier Technical Memorandum TM-9837, December 1999.
6. J.L. Rapanotti, A. DeMontigny-LeBoeuf, M. Palmarini and A. Cantin, "Developing Defensive Aids Suite technology on a virtual battlefield", SPIE AeroSense Conference, April 2002.
7. R.G. Lee, T.K. Garland-Collins, D.E. Johnson, E. Archer, C. Sparkes, G.M. Moss and A.W. Mowat, "Guided Weapons", Bassey's (UK) Ltd., Third Edition 1998.
8. V. Larochelle, D. Bonnier, D. Dubé, G. Tardif and J. Bédard, "Optical Detection of Snipers Using Albedos: November 95 Trial (U)" DRDC-Valcartier Report R-9625, June 1997.
9. P. Webb, S. Soltesz, A. Cantin, J. Fortin and D. Pomerleau, "Improved miniaturized HARLID™ for laser warning systems having high angular resolution", SPIE AeroSense Conference, April 2001.
10. J.L. Rapanotti, M. Palmarini and M. Dumont, "New computer and communications environments for light armoured vehicles", SPIE AeroSense Conference, April 2002.